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within the study area. Comparison of aerial photographs taken both before and after construction of Hells Canyon dam in 1965, as well as field mapping, show substantial decreases in both size and numbers of sand and gravel bars. From Hells Canyon Dam down to the mouth of the Imnaha River, the following changes in Snake River sand and gravel bars have occurred in the post-dam era: 1) severe decrease in numbers of sand bars, 2) severe size reductions in remaining sand bars, 3) cobble armoring of bars formerly composed of sand or gravel, and 4) increased vegetation on the highest portions of the few remaining sand bars. These effects are interpreted to have resulted from: a) deposition of sediments in upstream reservoirs which increase the streams' ability to erode bedload below the dam, b) frequent fluctuations in gauge height which result in loss of sand from the bar faces, and c) reduced magnitude and frequency of major floods which formerly tended to replenish the highest portions of the bars. During the same time sand bars in the lower, and completely undamed, Salmon River have remained stable or increased in size to reclaim areas affected by placer mining. They do not show armoring or vegetation of there upper surfaces. Snake River sand and gravel bars downstream from the mouth of the Salmon have undergone some degradation since construction of Hells Canyon dam. Sediment influx from the Salmon and Imnaha Rivers have mitigated effects of upstream dams on sand and gravel bars in this reach of the Snake River.

Nº 5642

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LATE CENOZOIC DISPLACEMENT HISTORY OF THE GRAND VALLEY, SNAKE RIVER AND STAR VALLEY FAULTS, SOUTHEASTERN IDAHO

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Our study of Miocene to Pleistocene volcanic rocks and upper Quaternary alluvial deposits establishes late Cenozoic displacement histories on three graben-bounding faults in Swan, Grand and Star Valleys. Two of these faults, the Grand and Star Valley faults, form a single continous listric normal fault that bounds the northeastern and eastern side of the graben. On seismic reflection profiles, these two faults appear to have back-slid down late Mesozoic thrust surfaces. The third fault, the Snake River fault, is an antithetic fault displaced only 75 m in the last 4.3 Ma. Although the depocenter, and consequently total displacement, is about the same everywhere in the graben, the timing of movement on the faults appears to be different in each of the three valleys.

The distribution of fault scarps in upper Quaternary deposits, the sinuosity of the adjacent Snake River and Salt River ranges, and the ages of faulted and unfaulted upper Quaternary deposits as estimated from soil development indicate that late Quaternary displacements have been restricted to the southern 28 km of the Grand Valley-Star Valley fault system. On this southern portion, maximum vertical surface displacements of 9 to 11.5 m in upper Pleistocene alluvial deposits yield a late Quaternary displacement rate of 0.6 to 1.2 mm/yr. In Swan Valley, Grand Valley and northern Star Valley, fault scarps were not observed in similar upper Pleistocene deposits.

Radiometric dating and paleomagnetic analysis of well-exposed upper Cenozoic volcanic rocks permit assessment of changes in displacement rate on the Grand Valley fault in Swan Valley. Since 6.5 Ma, this fault experienced a maximum displacement rate of 1.8 mm/yr between 4.3 and 2.0 Ma and a markedly lower displacement rate of 0.014 mm/yr since 2.0 Ma. The Quaternary Pine Creek basalt (1.5 ± 0.8 Ma) is offset 28 m in Swan Valley, yet no deposits younger than this basalt are observed to be offset *

Nº 5930

THE CARNIVORES OF PORCUPINE CAVE, PARK COUNTY, COLORADO

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Excavations in 1986 and 1987 at Porcupine Cave, an Irvingtonian site in Park County, Colorado have yielded the remains of snails, amphibians, snakes, birds, and a minimum of 42 species of mammals. At least 10 species of carnivores are represented.

Porcupine Cave is located in South Park, 40km south of Hartsel at an elevation of 2700m. It is the highest known Pleistocene site in Colorado and the richest fauna in species diversity in the state. An age of 400,000+ yrs B.P. is based on the presence of extinct species of microtine rodents (Microtus paroperarius, Pitymys meadensis, Synaptomys cf meltoni, and Ondatra annectens) that are known only from late Irvingtonian faunas.

Carnivores from Porcupine Cave include coyote and wolf, Canis spp.; small fox, Vulpes sp.; marten, Martes sp.; weasel, ferret and mink, Mustela spp.; badger, Taxidea taxus; spotted skunk, Spilogale sp.; and bobcat, Lynx rufus. In addition, the following species have been tentatively identified: short-faced bear, Arctodus sp.; American cheetah, Acinonyx sp.; jaguar, Panthera sp.; and cougar, Felis sp. Faunal studies are continuing and excavations at the cave will resume this summer.

Nº 18395

INFLUENCE OF GROUNDWATER ON RUNOFF AND SEDIMENT PRODUCTION IN A SEMI-ARID RANGELAND WATERSHED, SOUTHWEST MONTANA

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The concept of the partial variable area contribution to runoff and sediment production was investigated on Cottonwood Creek, a perennial, first order, rangeland stream near Norris, Montana. Analysis of runoff hydrographs and rainfall records along with field investigations indicate that less than 1% of the drainage basin generates runoff (1-2 acres of 514). These runoff generating areas also produce the bulk of the sediment delivered overland to the stream.

The runoff produced is generated by direct precipitation into the stream channel and onto groundwater discharge zones (seeps and springs). No events of Horton overland flow have been witnessed. The nature of the runoff (ie. total flow and peak discharge) is controlled by groundwater seepage area size and rainfall characteristics (amount, intensity and duration). Seepage areas vary in size through time and are controlled by a fluctuating groundwater table. Seepage areas are confined to zones and are not present along all reaches of the stream.

Overland sediment transport near the stream was measured in the field using overland flow sediment traps as an indicator for sediment delivery to the stream. Sediment was measured by the weight of sediment trapped. Amounts of sediment transported over seepage areas are an order of magnitude greater than over dry, vegetated surfaces (per linear foot of streambank). The main factors controlling sediment transport from seeps are the size and water content of the seep. Bare streambanks and cattle paths within the stream channel produce the greatest amount of sediment transported, an order of magnitude greater than seepage areas.

Nº 8143

ELEVATIONS OF SHORELINE FEATURES PRODUCED BY THE 1986-87 HIGH LEVEL OF GREAT SALT LAKE

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The elevation of shoreline features of Great Salt Lake provide much of the primary data for determining elevations of the lake particularly those prior to 1875 when the first lake level gauge was installed. The elevation of shoreline features produced by a lake is dependent on several conditions including the exposure and shape of the shoreline, the surficial geology, and the slope of the land both above and below the static water level. In 1986 and 1987, Great Salt Lake reached an historic high level of 4211.85 feet above sea level. Shoreline features associated with this static lake level have been measured at several locations on Antelope Island and elsewhere around the lake. Debris lines, beaches, and erosional cuts produced in 1986-87 range in elevation from 4213 to 4218 feet above sea level.

Nº 19091

PROTEROZOIC PLUTONIC SUPERUNITS IN THE GRAND CANYON

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Intrusive rocks of the Zoroaster Plutonic Complex (ZPC) which crop out in the Early to Middle Proterozoic section of the Grand Canyon show a broad range of age, composition and structure. However it appears that plutons of the ZPC can be distinctly grouped into at least three lithotectonic superunits. The Diamond Creek superunit is the most diverse, with compositions ranging from quartz-monzonite to diorite; but all plutons in this group show evidence of intrusion prior to Vishnu metamorphism and have initial-Sr ratios which center around .7025. The Phantom Canyon superunit includes mainly syntectonic plutons intruded during the late stages of Vishnu metamorphism. These are composed of granite or granodiorite and have initial-Sr ratios ca. .7040. The Surprise Canyon superunit consists entirely of anorogenic granite or granodiorite plutons and associated dikes, with much higher initial-Sr ratios of .7100-.7150.

There is no apparent spatial zonation of the superunits; plutons of all three types are distributed throughout the 200+ km east-west transect represented by exposures in the Upper and Lower Granite Gorges. The occurrence of these superunits reflects the crustal evolution of the Grand Canyon region from an immature oceanic arc at ca. 1800 Ma to a stable craton with incipient rifting at ca. 1400-1300 Ma.

Nº 16518

THE BEAR CREEK ANTICLINE, IDAHO: COMPARISON WITH FAULT PROPAGATION FOLD MODELS

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Structures present in the Idaho-Wyoming thrust belt have played a prominent role in our understanding of fold-thrust belt evolution (Armstrong and Oriel,1965). The well-exposed dip-domain geometry of the Bear Creek anticline (Caribou Range, SE Idaho) provides an opportunity to investigate the application of fault-bend and fault-propagation fold models to large scale natural folds. A part of the Absaroka thrust system, the anticline is in the HW of the Grand Valley normal fault and thus displays deformation characteristic of a higher structural level than usually observed in more deeply eroded portions of the Absaroka sheet.

In a section through the anticline near Palisades Reservoir, several units can be traced from backlimb to forelimb, and are folded with an angular bend geometry. Slickensides indicate that flexural slip was important in the folding process, but pressure solution and brittle deformation of competent lithologies are usually concentrated in hinge regions, and there is no evidence for hinge migration. The forelimb is steeply overturned, particularly in the deepest exposed levels of the fold, and most units in the overturned segments are thinned 20-30 percent relative to the backlimb. Ductile flow of incompetent units and some meso- and macroscale extension faulting of competent lithologies appear to be the thinning mechanisms. Geometrical constraints indicate a good match between the observed geometry and fault propagation fold models which incorporate forelimb thinning. However, it is not yet possible to rule out that the anticline is a fault bend fold which has been modified by a propagating thrust, rather than a fold developed above the tip of an advancing thrust.